MICHIGAN ENVIRONMENTAL SCIENCE BOARD
CHLORINE PANEL

MEETING SUMMARY
TUESDAY, JANUARY 18, 1994
ROOM A271, PLANT AND SOIL SCIENCE BUILDING
MICHIGAN STATE UNIVERSITY
EAST LANSING, MI

PANEL MEMBERS PRESENT:
- Dr. Lawrence Fischer, Chair
- Dr. Bette Premo
- Dr. Eileen van Ravenswaay

PANEL MEMBERS ABSENT:
- Dr. Richard Cook
- Dr. Raymond Demers

BOARD STAFF PRESENT:
- Mr. Keith Harrison, Executive Director
- Ms. Shirley Willis, Administrative Officer
- Mr. Alex Morese, Student Intern

I CALL TO ORDER

Dr. Lawrence Fischer, Chair, called the meeting of the Michigan Environmental Science Board (MESB) Chlorine Panel to order at 1:27 P.M.

II EXECUTIVE DIRECTOR'S REPORT

Mr. Keith Harrison stated that at the request of Dr. Fischer, MESB member Dr. Raymond Demers, has been added to the Chlorine Panel. Dr. Demers' role will entail review and evaluation of the various medical concerns involving chlorine. Dr. Demers will be in attendance at the next Chlorine Panel meeting.

Mr. Harrison indicted that to date considerable review information on chlorine had been received by the Panel from Dow Chemical Company, International Joint Commission (IJC), Chemical Manufacturing Association, U.S. Environmental Protection Agency, Ecology Center of Ann Arbor, World Wildlife Fund, Great Lakes Natural Resources Center, Michigan State Medical Society, Great Lakes Environmental Program, Michigan State University, CanTox, Inc., Michigan Chemical Council and the Michigan state departments of Agriculture, Natural Resources and Public Health.

Mr. Harrison informed the Panel that the next meeting of the Chlorine Panel had been scheduled for Wednesday, February 9, 1994. Thus far, two individuals had been scheduled to make presentations to the Panel, Dr. John Giesy from Michigan State University and Dr. Robert Soderstrom from the Michigan State Medical Society.

III PRESENTATION

Mr. Harrison introduced Mr. Tim Eder from the Great Lakes Natural Resources Center. Mr. Eder served on the IJC's Virtual Elimination Task Force and also co-authored the IJC article entitled, "Case Study, Application of a Virtual Elimination Strategy to an Industrial Feedstock Chemical-Chlorine." The purpose of Mr. Eder's presentation was to provide the Chlorine Panel with background on the Virtual Elimination Task Force's and IJC's recommendations on chlorine. A copy of his presentation is attached (see Attachment 1).

At the end of Mr. Eder's presentation, Dr. Fischer asked him who he thought should participate in a consultation to consider the sunsetting of chlorine. Mr. Eder indicated that should Michigan consider such a process, representatives from the environmental organizations, health organizations, Public Health Society, Michigan State Medical Society, state departments of Natural Resources and Public Health and producers and users of chlorine would need to be present.

Dr. Fischer asked about the apparent discrepancy regarding the IJC chlorine sunsetting recommendation and the IJC's Virtual Elimination Task Force's conclusions. Mr. Eder indicated that the IJC's Sixth Biennial Report came out after the Task Force issued its interim report. The IJC report called for a sunset, the Task Force report recommended phasing out the use of chlorine in the pulp and paper industry and then looking at the other uses. Within the Task Force, a consensus could not be reached due primarily to the makeup of the Task Force and the fact that the users and producers of chlorine did not believe that it was necessary to go as far as to sunset chlorine as a class. The Task Force did reach a consensus, however, regarding the need to sunset persistent bioaccumulative toxic compounds.

Dr. Fischer asked if Mr. Eder was suggesting that the proposed IJC chlorine sunset be implemented on a step-by-step basis, for instance by addressing certain large industrial processes, processes that use large amounts of chlorine and individual persistent toxic organochlorines, rather than an outright sunset of all uses of chlorine. Mr. Eder indicated that he was and that there would also need to be considered different time lines and different sunset dates for different uses and different applications.

Mr. Harrison indicated that there appears to be considerable confusion regarding exactly what the IJC report means in terms of sunsetting chlorine. For instance, the U.S. Environmental Protection Agency in their response to the IJC report apparently took it to mean something more than just industrial chlorine uses. And even at this meeting individuals representing different interest groups have expressed a slightly

different interpretation of the IJC's recommendation. Given this confusion, the Panel's response to the Governor must necessarily take the IJC's pronouncement to mean the total sunsetting of chlorine and respond accordingly. Mr. Eder stated that he did not personally interpret the IJC pronouncement that way but he would strongly encourage the Panel to seek further clarification with the IJC. He stated that the IJC Seventh Biennial Report was due to come out soon and should help clarify the issue.

Dr. Fischer asked Mr. Eder about the "weight of evidence approach" recommended by the Task Force and used by the IJC. Mr. Eder stated that it means not waiting until there is unassailable, irrefutable scientific proof of harm against every single chemical before taking action. Mr. Eder indicated that he would like to see the Panel consider in its deliberations, the use of a preventative approach, a "precautionary approach," that considers the weight of evidence and makes assumptions where there is some basis in science to conclude that because of the number and similar characteristics of chlorinated compounds, actions should be taken to restrict and eliminate some.

IV PANEL MEMBER ASSIGNMENTS

Dr. Fischer indicated that he was responsible to look at the mammalian and human toxicity concerns. He stated that in support of the chlorine ban, he has found considerable literature on the known chlorinated persistent toxic compounds, most of which have already been discussed. However, the compounds addressed in the literature account for only a small portion of the total chlorine chemistry picture. On face value and in the absence of toxicological literature on the bulk of organochlorine compounds resulting from chlorine chemistry, the IJC proposal to eliminate the use of chlorine as an industrial feedstock appears to be a large extrapolation from known facts.

Dr. Fischer stated that he is interested in obtaining any published and unpublished data which identify the types and concentrations of organochlorines used in the current industrial and chemical processes and are contained in the effluents resulting from these processes. In particular, he wants to determine whether the effluent chlorine compound mixtures might contain large amounts of relatively inactive substances, biologically, or whether it is likely to have biologically active and presumably toxic compounds.

He stated that the IJC was looking at chlorinated compounds as a biologically similar group of chemicals. He was uncertain if that was a valid approach and indicated that he intended to look at the toxicity of various organochlorine compounds to compare the types of toxicity produced and their potency.

Dr. Fischer also stated that he wanted to look at the organochlorines in terms of chlorine's ability to dictate the biological activity of a particular molecule. It is currently his understanding that chlorine does not have much ability to dictate quantitatively the biological activity of a particular molecule. The continued addition of chlorine atoms to a molecule will maximize the potency of the molecule and then, under most

circumstances, begin to result in decreased biological activity with additional chlorine atoms. In terms of pharmaceuticals, chlorine can either increase or decrease activity but that the type of activity of a particular molecule is not really dictated by the presence of chlorine.

Dr. Bette Premo indicated that she was to look at the environmental and wildlife concerns and evaluate the persistence of different types of chlorinated compounds. She stated that most ecosystem studies appear to focus on the effects of exposure to toxic effluent on organisms that are restricted to the water column and the sediments. The contaminants are transferred from the aquatic system or sediments to the terrestrial animals by fish consumption. Species that eat high in the food chain, are more likely to experience adverse effects, especially if biomagnification is involved. The transfer of these kind of contaminants is of greatest concern for those compounds that can be classified as hydrophobic (compounds such as dioxins, PCBs, DDT and mirex).

It appears that in ecosystem effects there may be a delay between the time of the discharge and the time at which the biological effect occurs. The delay has to do with what happens to a chemical once it's discharged. The chemical may be in solution or it may be associated with particulates. Dissolved substances may be taken up by organisms through absorption or rapidly through the respiratory system. Particulates, when they absorb the chemical, may get into the sediment. If these compounds are hydrophobic, they may sit in the sediments for long periods of time and the release may be slow or episodic. The chemicals in the sediments may be released again through the water column and be resuspended or taken up by benthic organisms.

Examples of documented wildlife effects are presented in Attachments 2 and 3. The examples show the kinds of wildlife effects which have been observed, including endocrine disruption, estrogenesis, reproductive failure and eggshell thinning. Based on the examples, the chlorinated compounds blamed for this are the dioxins, furans, PCBs, DDTs and mirex.

The last example (see Attachment 4) comes from a draft paper entitled, "A Review and Assessment of the Ecological Risks Associated With the Use of Chlorine Dioxides in the Bleaching of Pulp." The paper was prepared by a scientific advisory board for the Association for Environmental Technology. The document contains a table showing the relative degree of biological activity based on hydrophobicity versus nonhydrophobicity for different kinds of chlorinated organics.

The compounds at the bottom of the table are considered very hydrophobic. The more hydrophobic a compound is, the more soluble it is in lipids and the higher its bioconcentration factor, which means it has more of a tendency to be concentrated up the food chain. The compounds at the bottom of this list, the furans and the dioxins, are shown to have a high partition coefficient, being very hydrophobic and having a high bioconcentration factor. Going up the list, the compounds that have been studied, which in this particular case include a lot of the chlorinated phenols, have a relatively moderate hydrophobicity. Going further up the list, the compounds become essentially

nonhydrophobic. And at the very top of that list is what is called AOX, absorbable organic halogens. AOX is the name of a method which is viewed as determining the total quantity of organically bound chlorine. AOX consists of a mixture of high and low molecular mass organochlorines.

For the persistent hydrophobic chemicals like furans and dioxins, there is a very good understanding of the fate and the ability to link the loading with the concentration seen in the environment. Degradation in the environment is very slow with the half-lives measured in years. The partitioning of the phenols is less understood. The half-lives of these compounds are measured in weeks and months. They do bioconcentrate, but to a much lesser degree than those that are farther down the list, like the furans and the dioxins. At the very top are the AOX compounds again, which represent by far the majority of compounds that are discharged, for example, in the pulp and paper industry.

There is another test called EOX (extractable organic halogen), which is a fraction of AOX. EOX is that portion which is extracted in a nonpolar solvent, like hexane or heptane. The substances which are extracted in EOX are hydrophobic, like the furans and the dioxins and some of the more highly bioaccumulative compounds.

The studies which have been done on pulp and paper effluent to determine what percentage of AOX is EOX, have demonstrated that EOX compounds represent a small percentage. A few percent of the AOX value is EOX, indicating that most of the total organic halogenated compounds discharged are nonhydrophobic. This information points to the fact that the majority of the organic halogens being discharged in this case do not bioconcentrate and that their toxic effects may be restricted to things like direct absorption on respiratory surfaces, something other than toxic persistence effects that are observed with dioxins and furans.

More information of this kind is needed since it would provide better understanding of the chlorinated organic compounds and a scientific way to look at their characteristics and how they are biologically active in the environment.

The reason that this particular study was put together was to determine a risk assessment of using a substitute of chlorine dioxide for chlorine in the bleaching process of the pulp and paper industry. The study was called for because there have been aquatic ecosystem studies in the past that have shown that relative to pulp mill effluent, there are effects on benthic flora and fauna as related to distance from the discharge. There were also species diversity and population effects on algae, plants, fish, and macroinvertebrates, and increases in diversity in populations as the distance from the discharges increase.

There may be many reasons that these kinds of effects are being observed. One of them may be the presence of persistent toxic chemicals. Other reasons may be substances that are being discharged, like excess nutrients; increased discharge of colored substances, which create a situation where there is not as much sunlight penetration into the water; suspended solids release; or release of lignins and tannins

from the pulp and paper industry, which in themselves can cause endocrine effects because they are organic substances, creating effects that have not been separated yet from chlorinated hydrocarbons.

It is not clear at this time what is causing these effects. However, the few studies we do have show that certain kinds of substitutes (in this case, the substitution of chlorine dioxide for chlorine) create a situation in which the effluent has fewer of the hydrophobic substances in any percentage and, therefore, is creating in both infield and microcosm studies, fewer effects as a discharge than the use of chlorine. Additional studies involving these types of risk assessment investigations are needed. However, before substitutes are recommended they must be thoroughly studied.

Dr. Fischer commented that Dr. Premo's concern may be best exemplified by a recent situation in which he was a part. He stated that he was in a larger group studying new technology and the remediation of superfund sites. One of the investigators looked at the products produced by ozonation and the products produced by bioremediation. The products were extracted as a mixture in each case and tested to determine if the products in the mixture altered the ability of cells to communicate with one another. The products of ozonization were found to be much more toxic than the products of the particular bioremediation process.

Dr. Eileen van Ravenswaay indicated that she has been looking at the question of what the economic impacts would be if the use of chlorine was eliminated. The process has involved looking at products which either contain chlorine or are produced using a chlorine-type process.

The economic impact of banning chlorine depends on the availability of substitutes for chlorine products, either chlorine-containing products or products that are made using chlorine in the process. In addition, it also depends on the ability of the substitute to be close in price, safety and effectiveness as the original chlorine product.

Because of the amount of chlorine involved, Dr. van Ravenswaay indicated that she would be concentrating her investigation on four case study areas, pulp and paper, PVC, water treatment and pesticides, and their alternatives. Lastly, another area she is looking at the importance of chlorine in Michigan's economy. Some of that information is contained in the literature, particularly the Charles River Associates report, but the numbers in that and other reports need to be verified.

Dr. Fischer asked when the industry made its estimates of how much it will cost, did it discuss the alternatives? Dr. van Ravenswaay answered that the Charles River Associates' report did proceed on that basis, by looking at each product group and trying to identify what the substitutes would be. In terms of documenting what they found, however, it is not well referenced.

Dr. van Ravenswaay indicated that finding the substitutes is one of the key points that needs to be looked at in doing the economic evaluation. However, there are also a

number of assumptions that come into play. Once the substitute is identified, it is necessary to gain some sense of what the cost of using that substitute would be relative to the present costs. In addition, there must be an awareness of the impact of the start-up costs that may be involved with the use of the substitute.

Mr. Harrison asked if the economic studies for either the chlorinated compounds or their substitutes looked into the environmental costs? Dr. van Ravenswaay answered that they did not.

Dr. Premo stated that she was concerned about the replacement of PVC water piping with copper tubing, because right now there's a national analysis of copper in drinking water going on because of copper toxicity. Although it may be minor in the whole realm of possible substitutes and possibilities, it is an example of how a substitute's economic effect also needs to be considered environmentally.

Dr. van Ravenswaay stated that she would be interested in receiving information from Europe regarding the basis for their decisions and what processes they were adopting in place of the use of PVC.

Mr. Harrison stated that he was supposed to look at the Michigan regulations governing the use of chlorine. He indicated that he had contacted the regulatory agencies within Michigan and asked them to identify the various regulations which addressed chlorine and chlorinated compounds. In addition to that, and at the request of the Panel, he also looked at the federal regulations.

Twelve federal and 11 Michigan regulations were identified, each having some regulatory component involving either chlorine or chlorinated compounds. The federal and the Michigan regulations, for all practical purposes, overlap. Very few instances were encountered where Michigan regulations did not either meet, or in some instances, exceed, the federal requirements.

Where available the compiled material also indicates the number of chlorinated compounds regulated. For instance, under the Pesticide Control Act, the Michigan Department of Agriculture registers over 11,000 pesticides for use in the state. Of these, 360 are classified as restricted use, and of those only about 5 percent are actually chlorinated organics. On the other hand, under the Hazardous Waste Management Act of Michigan, there are many chlorinated compounds that are considered hazardous waste and, therefore, regulated.

V PUBLIC COMMENT

Tracey Easthope from the Ecology Center expressed the importance for the Panel to hear from several prominent scientists, including Dr. Theo Colborn, Dr. Robert Soderstrom, Dr. Ross Hume Hall and Dr. David Ozonoff, all of whom are working in the area of the Panel's investigation. She particularly desired the Panel to be cognizant of

Dr. Colborn's work on endocrine disruption. In addition, she also expressed the need for the Panel to receive testimony from the IJC. Finally, she expressed her concern regarding the inadequacies of the Charles River Associates report.

Mr. Bill Bajzer of Dow Corning, indicated that Dr. van Ravenswaay might find it useful to acquire a copy of the Chemical Economics Handbook for her portion of the investigation.

Mr. Mel Visser of the Upjohn Company, questioned the validity of the IJC contention that the pharmaceutical industry accounted for only one percent of the chlorine use. He indicated that while Upjohn uses a small amount of chlorine in its complex and for water chlorination, it uses about 10-times that as chlorinated intermediates and 75-times that as chlorinated solvents. He questioned if the IJC's recommendation meant just chlorine or chlorinated compounds in the feedstock?

Dr. Fischer stated that he has taken the recommendation to mean all chlorinated compounds. Until the Panel obtains and reviews the IJC Seventh Biennial Report, it must be assumed that all uses of chlorine, including pharmaceuticals, are not exempted.

Mr. Harrison introduced Alex Morese, who is a Michigan State University graduate student working with Dr. van Ravenswaay, through the MESB office.

VI NEXT MEETING DATE

Mr. Harrison indicated that the next meeting would take place at 1:00 p.m. on Wednesday, February 9, 1994 at the Plant and Soil Science Building (Room A271) on the campus of Michigan State University.

VII ADJOURNMENT

The meeting was adjourned at 3:55 p.m.

Keith G. Harrison, M.A., R.S., Cert. Ecol.
Executive Director

Attachment 1. Summary of January 18, 1994 Presentation by Mr. Tim Eder, Great Lakes Natural Resources Center, NWF to the MESB Chlorine Panel.

Mr. Eder stated that although he served on the IJC's Virtual Elimination Task Force, he would not be addressing the Chlorine Panel as a scientist or on behalf of the IJC.

The Virtual Elimination Task Force was divided on the issue of chlorine, since there was no conclusive scientific evidence as to whether or not chlorine should be sunset. Its final report recommended only that consultation begin about uses that should be phased out, and methods and timetables for doing so. The IJC itself recommended that all new human inputs of chlorine be discontinued (virtual elimination) on the basis of a "weight of evidence" approach - that at some point the emerging mass of data must be accepted as sufficient to prompt action and avoid possible risk.

Although there is no definitive set of facts to help decide the chlorine issue, there is accumulating evidence of chlorine-related environmental problems. He urged the Panel to consider that evidence in a new light and not wait until certainty is absolute. Current toxicological science cannot predict the outcomes of all the possible chemical mixtures that can occur in nature, nor can the tenet that a substance is only poisonous at a certain threshold exposure help in understanding either bioaccumulative effects or how the timing of even a small exposure affects an organism. The latter has become an issue in current research that links endocrine disruption with chlorinated compounds. He recommended that the panel speak to Dr. Theo Colburn or Dr. Ross Hall about their research before making a decision.

Mr. Eder agrees with the IJC's position that since it is not possible to remove a persistent toxic substance from a source or from the environment once that substance has been produced, the focus must be on preventing the generation of the substance in the first place, rather than trying to control use and disposal after it is produced. In order to do this the entire life cycle of persistent toxics must be understood. In the case of PVC, one of the major sources of chlorine, there are three points in the life cycle where dioxins and furans are released: during production; during disposal of the sludges created during production of ethylene dichloride, which is used to produce PVC; and at the point of final disposal. His opinion is that regulating the release of chlorinated compounds will not be adequate in itself; the only way to get rid of them is to stop their manufacture and use.

The two predominant uses of chlorinated compounds in the U.S. and Canada are in the manufacture of PVC and in the pulp and paper industry. In both cases there are practical alternatives to chlorine in use now, mostly in Europe. And there has been progress in finding alternatives to chlorinated solvents. While cost and timing considerations can be formidable problems, they are capable of resolution. Mr. Eder urged the Panel to consider the Task Force recommendation and initiate a consultation and review process for deciding whether and how to eliminate chlorine, with the participation of environmental, industrial, business and other interested parties.

Mr. Eder ended his comments with an evaluation of whether Michigan's current laws and regulations are adequate to protect Michigan's citizens from chlorine. Mr. Eder felt that Michigan's regulations were not adequate. The data requirements to set a water quality standard are unrealistically rigorous; detection limits are too high, so toxics that are undetectable, but harmful, go unchecked; and current methods are unable to deal with a multimedia approach, looking at the myriad ways a toxic enters the environment, instead of assuming that control of one source will take care of a problem.